Sustainable Fuelwood Supply and Management in Yobe State, Nigeria: A Local Approach to Addressing Energy Demand in Sub-Saharan Drylands.

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Abstract
The increasing demand for fuelwood in Sub-Saharan Africa, driven by erratic rainfall and rapid population growth, presents significant challenges for energy sustainability in the region. Yobe State, located in the extreme northern part of Nigeria within the Sahel zone, relies heavily on fuelwood as a primary energy source, with approximately 98% of rural households depending on it for cooking and other activities. This article investigates the fuelwood supply dynamics within a 30km radius of Yobe State Polytechnic, Geidam, exploring the socio-economic and environmental factors influencing its use and management. Using data collected through questionnaires and interviews with local stakeholders—including crop farmers, pastoralists, mixed farmers, and other community members—the study identifies key issues affecting fuelwood availability, such as deforestation, land use conflicts, and inadequate policy enforcement. The results reveal an urgent need for sustainable management strategies, including the establishment of woodlots, forest reserves, and the promotion of alternative energy sources like kerosene and coal. By adopting participatory approaches and community engagement, the study offers a framework for addressing the region's fuelwood challenges, aiming to ensure a sustainable energy future for Yobe State and similar dryland regions in Sub-Saharan Africa.

Keywords: fuelwood, Sub-Saharan Africa, Population, Stakeholders, Yobe State.

Introduction

Rainfall in Sub-Saharan Africa is unpredictable, averaging no more than 800 mm per year (DFID, 2001). With the region's population projected to double to 1.3 billion by 2025 (DFID, 2004), there is a significant risk of a crisis in meeting the demand for fuelwood.

Yobe State, located in the extreme northern part of Nigeria within the Sahel zone, experiences even lower rainfall, generally less than 500 mm annually, with vegetation reaching up to about 9 meters in height. Common tree species in the region include Acacia radiana, A. senegal, A. seyal, and various shrubs such as Salvadora, Laptadamia, and several species of Grewia. In this part of Nigeria, fuelwood is a crucial source of energy for cooking and other household activities. It is estimated that about 98% of rural households in Yobe State rely on firewood as their primary domestic energy source (Arufor, 2001).

Much of the fuelwood in Yobe State is sourced from forests, with many rural residents making a living by collecting firewood for sale in urban areas, despite existing regulations. The commercial value of fuelwood often leads to it being transported over long distances (Folliot et al., 1995). Recent reports suggest that fuelwood extracted from Yobe State's natural forests is also being transported to neighbouring states, such as Kano, Jigawa, and Borno, where forest laws are more strictly enforced than in Yobe. Figure 1 illustrates the transportation of fuelwood to urban centers.

This research aims to propose a local strategy for establishing a sustainable supply of fuelwood to communities within a 30 km radius of the Mai Idris Alooma Polytechnic in Geidam. Data were collected using questionnaires, and key stakeholders, along with relevant issues and influences, were identified. The study also offers suggestions for meeting the community's demand for wood fuel**.**

Fig.1 An open vehicle transporting fuelwood to a long distance

Literature Review

The drylands of Africa are home to around 325 million people, which is roughly 45% of the continent's total population (UNDP, 2001). In these regions, environmental degradation, poor agricultural output, and low economic development are closely intertwined with factors such as population growth, migration, and poverty. Additional contributing factors include ineffective government policies, market failures, and political conflicts (World Bank, 1995, in FAO, 2003).

Northern Nigeria, where rainfall rarely exceeds 1000 mm annually (Aruofor, 2001), forms the country's dryland region. This area is characterized by low rainfall, extended periods of intense heat, low humidity, and high evaporation rates. Other African countries with similar conditions include Kenya, Zimbabwe, Sudan, Niger, Ghana, and Cameroon, among others. Table 1 provides a classification of Africa's dryland areas.

Table 1: Classification of the dryland zone of Africa

Zone	Area (Million ha)	Percentage (%)
Arid	505	17
Semi-Arid	507	17
Dry sub-humid	281	09
Total	**1293**	**43**

Source: UNDP/UNSO, 1997.

In Nigeria, fuel wood is a primary source of energy for cooking and other activities. It accounts for over 50% of national primary energy consumption (FAO, 2003). It is calculated that about 98% of the rural household in the northern part of the country, Yobe State inclusive, depend on fuel wood as their domestic source of energy (Aruofor, 2001). Although the country has dedicated about 17,000ha of non industrial plantations, mainly fuel wood, these plantations are, unfortunately, badly degraded by excessive cutting (Mantalembert and Clement, 1983). Presently, most of the fuel wood comes from the forest, as could be observed in table 2.

Table 2: poverty rate and percent of wood as fuel source by geopolitical regions

Region	Poverty rate	Percent of wood as fuel source
North East	**72.2**	**95.9**
North West	**71.2**	**95.3**
North Central	**67.2**	**86.4**
South West	**43.0**	**54.9**

South East	**26.7**	**78.6**
South South	**35.1**	**72.7**

Source: Zaku, et al (2013)

The Impact of Poverty on Wood Fuel Consumption

This review draws on data from the National Bureau of Statistics (NBS, 2007) and other sources. Findings are presented in Table 2, and a correlation analysis was conducted to explore the relationship between poverty levels and wood fuel consumption across different regions. The study examined the average percentage of wood used for cooking in 2007 within Nigeria's six geopolitical regions, comparing these figures to the poverty levels in each region (Table 2).

Table 2 clearly indicates a strong correlation between poverty rates and the use of wood as a primary cooking fuel, with the notable exception of southeastern Nigeria. In this region, despite a lower poverty rate compared to southern Nigeria, the use of wood fuel for cooking is higher.

Overall, the analysis reveals a correlation coefficient of 0.771 (significant at the 5% level), indicating that poorer regions tend to rely more heavily on wood fuel to meet their domestic energy needs. This finding underscores the significant role poverty plays in driving wood fuel consumption. Regions with higher poverty rates, such as Northern Nigeria, tend to have less woody vegetation compared to wealthier regions, like Southern Nigeria. In the northern regions, forests are nearly non-existent, except for scattered patches of trees in the northwestern and northeastern areas, and the relatively better-off north-central part, which lies within the Savannah zone.

Despite having fewer forest resources, these northern regions consume more wood fuel than the southern regions, where forests are more abundant. This is largely due to the higher poverty rates in the north. A critical consequence of this trend is the increasing pressure on the already sparse forests in the northern regions. Over time, this is likely to lead to a greater movement of wood fuel, particularly commercially processed charcoal, from the forest-rich southern regions to the north. This shift will further strain the overexploited forests across the country.

Most countries in Africa extract fuelwood from either natural or secondary forests. Most often, however, this is done in an unsustainable fashion. For example, in Botswana, it has been estimated that the country currently consumes more wood fuel than it is replaced naturally: 2014000m^3 for consumption and 199300m^3 of production (FAO, 2002a). In Ethiopia, wood is also the main energy source for urban and rural people. Over 90% of wood produced in the country is utilized as firewood (Sands, 2005). Wood for rural and even construction also comes from trees planted on farms, and plantations (FAO, 2002b).

Fuel wood accounts for 51% of domestic energy use in South Africa, which gives a representation of the highest volume of forest products used by rural people (Geldenhuys, 1998 in FAO, 2002c). In some areas of the country, consumption for fuel wood could be as high as 80%. The gathering of fuel wood mostly focuses on forests where woodlots or exotic plantations do not surround forest and woodlots have not been developed. Estimates have shown that between 9 and 11 million tons of wood are used for fuel per year. The amount consumed for household needs nearly

equals that used in the formal forest industry (MWAF, 1997).

In Ghana, more than 90% of the population depends on fuel wood as their main source of energy (Asselin, 2004), just as in Zimbabwe where over 80% of the population were reported to depend on it ((UNEP, 2001).

Study Area

This research was conducted at the Mai Idris Alooma Polytechnic, Geidam which has the following geographical location as$12^0 53' 49"$ N $11^0 55' 49"$ E and surrounding communities spanning a distance of about 30km radius. Geidam town, three rural communities and 5 pastoralists' camps, "*Ruga"*, were all considered as part of the study area.

Methodology

Data Collection

The primary tool for data collection was a questionnaire. A total of 25 questionnaires were randomly distributed across the study area among key stakeholders. Specifically, 7 questionnaires were distributed in Geidam town and 7 at the Polytechnic. Additionally, 1 and 2 questionnaires were respectively distributed in each pastoralist camp and rural community. Data was also collected through verbal interviews and the author's personal knowledge.

Despite the random distribution of the questionnaires, efforts were made to ensure representation from all interest groups or stakeholders. For instance, both senior and junior staff members of the Polytechnic were interviewed, as well as individuals perceived to be among the wealthy, middle class, and lower-income groups in Geidam town, including women. Interviews also included local leaders, such as the Bulama's and Lamido's, as well as their subjects in rural and pastoralist communities.

Collecting information from some of these groups, particularly those in rural areas and among pastoralists, proved to be quite challenging. This difficulty was not due to any direct intervention by their local leaders, but rather, it is argued, because of a pervasive fear that the government might use the information gathered to impose stricter regulations on the use of forests and forest resources, which are vital to their livelihoods, either directly or indirectly.

Results

The results obtained from the questionnaires administered have been compressed and summarised in table 3. The table have been designed in this way so as to reduce ambiguity or complexity of the results and for ease of analysis.

Discussion

Stakeholders

Results obtained indicated that the local population of the study area is about 40,000-47,000 people. The major stakeholders within the area include:

(I). **Crop Farmers**- This stakeholder group has the highest population as about 55% of people within the study area were considered to be crop farmers. These are people whose major source of livelihood is assumed to be the production of crops only. Average size of households is about 09-10 people. Average fuelwood demand per person per week is about 4 bundles[1] (approximately 32-40kg per week). Average fuelwood demand per year per person may be as much as 1664-2080kg as against the 200-400kg suggested by published estimates. The author has expected that the fuelwood demand for this stakeholder group to be lower than the figures

[1] A bundle is approximately 8-10kg, depending on the degree of dryness.

obtained as most people in the group can not afford three square meals. Generally, it is important to note, however, that bundle size differ from one locality to the other even within the study area. In addition, fuelwood extracted, most often than not, are high in moisture hence, higher values of weight. This stakeholder group ranks last in terms of income as it is the group that suffers extreme poverty, with about 70-80% been extremely poor, as indicated in table 3. This, probably, may be as a result of most people having undefined job and the subsistence nature of their farms- produce not enough to sustain families over a year period.

(II**). Pastoralists-** From table 3, it could be observed that the population of this group within the area of study is about 9% while average size of households is 10-12. Fuelwood demand is approximately 2 bundles (16-20kg). This figure is low compared to other stakeholder groups because they, most often, supplement fuelwood with animal dung, particularly, cow dung, because of its availability. Annual average fuelwood demand lies between 832-1040kg. Results obtained from the study indicated that the pastoralists' ranks first as far as income are concerned as only 10-20% is poor. It is pertinent to at this juncture, note that this stakeholder group do not have liquid cash but can be able to at any point in time, convert the animals they have (cows, donkeys, sheep, goats, poultry etc.) into liquid cash to meet their needs.

Table 3: Summary of Results

	Crop Farmers	**Pastoralists**	**Mixed Farmers**	**Others**
Population of different stakeholder groups in the study area (%)	55	09	20	16
Estimate of fuelwood used per household per week (Bundles)	04	02	03.5	03
Poverty level of stakeholder groups	70-80% very poor	10-20% poor	35-47% poor	41-55% poor
Estimated portion of land used by stakeholder groups (hectares)	01-02	>10	05-12	<01
Size of household of stakeholder groups	09-10	10-12	10-14	08-10
Means of obtaining fuelwood	Purchase and gather by themselves	Gather by themselves	Purchase and gather by themselves	purchase
Main source of obtaining: (I)Food (II)Water	Forest/Farm Wells/Streams	Forest/Farm Streams/Ponds	Forest/Farm Wells/boreholes	Purchase Boreholes
Current fuelwood demand/week (bundles)	O4-05	02	04	03
Estimate of total area covered by woodland in the study area	19-25km^2			
Four areas that supply fuelwood outside the study area	1. Garin Mai Aduwa 3. Kanamma 2. Kelluri 4. Gumsa			
Two areas of conflict on land/woodland use in the study area	1. Animals' grazing on farms after harvest, gum Arabic or other economic trees' plantations. 2. The use of *Fadama* land or water sources such as wells, ponds/rivers.			
Reasons for conflict on land/woodland use in the study area	Damage to farm produce, economic trees or the use of water sources e.g. wells, ponds, etc.			
Ways of resolving conflict on	Intervention/involvement of local leaders, organising dialogue, maintenance of grazing and forest reserves etc.			

land/woodland use in the study area	
Estimate of likely shortage of fuelwood that may result in 10years	
Ways of improving supply of fuelwood within the community	Management/maintenance and establishment of woodlots/plantations, forest reserves and encouraging trees planting at home and farms, use of alternative sources such as kerosene stoves, subsidy on petroleum products e.g. kerosene and cooking gas, use of coal etc.

(III). **Mixed Farmers-** People from this stakeholder groups are engaged in both farming and raising of animals, although the animal size may be as low as 5; and population and household sizes of about 20% and 10-14 people respectively (see table 3). Fuelwood demand per week per household may be up to 3.5 bundles (28-35kg) per week, i.e. an average yearly demand of about 1456-1820kg. 35-47% of the group, as indicated by the results, are poor. This group ranks second to the pastoralists in terms of income generation.

(IV). **Others-** This stakeholder group has a population size of about 16% within the study area. Although there are a lot of wealthy people within the group, results obtained (table 3) indicates that 41-55% is poor. Average household size is about 8-10 people while fuelwood demand per household per week is about 3 bundles (24-30kg). Average yearly fuelwood demand, therefore, is about 1248-1560kg. Low value of fuelwood demand within this group, compared to crop and mixed farmers, was obtained probably for fuelwood and timber).

because there are people that use alternative sources of energy particularly, electric stoves/cookers and kerosene stoves.

Issues and Influences

From table 3, it could be observed that estimates of total area of woodlands within the study area were given to be 19-25km^2. There has been difficulty in arriving at this figure as there are no documented records of available woodlands within the study area. Greater percentages of available woodlands are governments owned, established in its drive to checkmate desertification (see fig 2). Few of these woodlands, mostly *Acacia Senegal*, are privately owned. All efforts to establish the area estimates of these woodlands proved abortive as some of those interviewed are not conversant with area measurements and in some cases, even the existence of some of the woodlands. It may be important to note, however, that most of these woodlands have greatly been tempered with (cut down

FIG 2: A plantation established by the Government

The proportion of land used by each stakeholder group, especially the pastoralists, was found to be difficult. These are people that move from one end to the other in search of water and pasture/fodder irrespective of the distance. Results obtained from the study indicated that they make use of at least, more than 10 hectares as these areas have very scanty or patchy feed for the animals. Mixed farmers and crop farmers were found to use 5-12 and 1-2 hectares respectively while others make use of less than a hectare. Open grazing is the most common method of grazing in the area and there are no limits to these areas. Although government have demarcated some areas as forests and grazing reserves, most of these have been converted to farmlands.

Fuelwood demand of the inhabitants of the area, as indicated by the study, can only be met when it is imported from some other areas. There are other areas that have denser forests and less population, which supply the study area and even urban cities with fuelwood. These, amongst others, include Garin Mai Aduwa, Kelluri, Kanamma and Gumsa areas. Crop and mixed farmers acquire their fuelwood by either purchasing from cart pushers/open vans/lorries or gather by themselves as most of them cannot afford buying all the time. Fig 3 shows how poor people used animals for firewood transport/trading while fig. 4 shows a fuelwood market some 400m away from the polytechnic. Other people, especially those residing in Geidam town, most often purchase their fuelwood from vendors as they have to travel over a long distance before they can gather by themselves while the pastoralists need not to purchase as they are always in the bush and do supplement with animal dung. Cases of exchanging fuelwood and other goods have not been established from the study. It is also not known to the author whether this practice does happen.

Fig. 3: Animals are used for fuelwood transport/trading

Fig. 4: A fuelwood market in Geidam town

Conflicts on land and/or woodland use occur a time, as reported in table 3. Some of the areas of conflict include the grazing of pastoralists' animals on farmlands and economic trees plantations before such places becomes due for the practice; and the use of *Fadama* areas either for grazing or in search of water. The *Fadama* is a rallying point for nearly all stakeholder groups- mixed farmers, pastoralists' hunters, fishermen, crop farmers (those practicing irrigation farming), etc. Similarly, conversion of forests and grazing reserves into farmlands has always been a source of conflict between different stakeholder groups within the study area.

Other issues that have influence on the local population and to a certain extent, the

extraction of wood fuel, are that of food and water sources. The forest plays a very vital role in providing food to nearly all the stakeholder groups as could be observed in table 3. Such things as leaves, mushrooms, honey, and bush meat amongst others do compliment what stakeholders can put on the table from their farms. Water, especially stream and pond waters, in the forest influences nearly all stakeholders as they depend on it for direct consumption, animals, fishing, moulding bricks etc. There is also such other issue as land tenure system and government's top-down approach to forestry or forestry related projects or programmes implementation.

Meeting Wood Fuel Demand

There are a number of suggestions offered by those interviewed, as could be observed in table 3, as per how the fuelwood demand of the study area could be met. At this point, it will be pertinent to look at the current and future fuelwood demand. Estimates from the study indicate that the current yearly fuelwood demand is about 6656-7821tones. Considering a population growth rate of 2% per annum, future wood demand of the inhabitants of the study area (in the next 10 years), could be put at about 79870-93850tones (see appendix 2). As earlier observed, however, standing trees are felled in some instances in the process of extraction, hence higher values of weight because of high moisture content.

One of the ways through which future fuelwood supply in the study area can be enhanced, as noted in table 3, is the management/maintenance and establishment of woodlots/plantations and forest reserves. A well-planned management strategy put in place will no doubt ensure sustainability of the available woodlots/plantations, as such things as selective harvesting of wood can easily be adopted. A careful extraction of fuelwood from these sites will no doubt reduce the pressure on natural forests. A similar effort in Kano/Jigawa States of Nigeria, as reported by Onyewotu *et al.* (2003) has ensured a selective wood harvesting from shelterbelt trees established in the area as could be observed in figure 6, there by reducing the problem of forest management. Although yield of no more than 2-4m^3 /ha/year may be obtained, establishing plantations still remains one of the solutions to fuelwood supply in the area. If a 150ha plantation will be established, for example, a yield of about 300-600m^3 may be obtained. This coupled with supplements from other sources and with good management strategy put in place, can ensure steady and sustainable supply of fuelwood in the area. There is also the need to protect the natural forests from fire in order to maintain tree cover.

Encouraging trees planting at home and farms has also been suggested as one of the ways through which fuelwood supply in the area can be met. Planting trees on farms (farm forestry), has also been suggested by Hardcastle (2006) as one of the technical packages that could be employed in forestry interventions. Hence, this practice can ease the pressure on natural forests and ensure sustainability of fuelwood supply. The author is of the opinion that this practice will not only help in the supply of fuelwood, but also empower locals as such trees as *Acacia Senegal*, with the ability of providing Gum Arabic, fodder and fuelwood can be used. Thus, alternative sources such as the use of kerosene stoves and coal can be a possibility. Additionally, all the positive indicators and suitability of this package as enumerated by Hardcastle (2006) have indicated that the practice can be employed in the area without much difficulty (see table 4.)

Table 4-Indicators and Suitability for Farm Forestry in Forestry Interventions

Positive Indicators, suitable for:	**Key considerations for Forestry Agency:**
• Settled populations most likely to take up agroforestry • Areas of high potential with intense land competition to increase productivity • Marginal areas to reduce risk and increase income • Areas where seasonal hunger is significant, in order to provide alternative income and products	• Develop site and location-based intervention guide • Provide training for Forest Rangers and farmers • Engage Community Development specialists if community wide approaches are to be used • Link to other departments (Livestock, Agriculture)

Source: Hardcastle (2006)

The use of kerosene stoves and coal has earlier been mentioned as one of the ways through which supply can be enhanced. In this regard, there must be massive mobilization amongst most of the stakeholder groups, on the advantages and otherwise of continues felling of trees for use as fuelwood. Additionally, government must subsidies kerosene, cooking gas and coal with the overall aim of supplementing the use of fuelwood. Presently, only few people can afford the use of coal. Fig 5 shows one of the coals selling outlet in Geidam town.

Fig. 5: A coal selling outlet

Putting strategies that will ensure fuelwood supply in place can be difficult if potential issues that may lead to conflict are not addressed. Results obtained have suggested that one way through which conflicts on forest resources can be reduced is by involving community leaders, the *Bulamas* and *Lamidos*, and encouraging dialogue. This means that if participatory approach to forest resources management can be employed, conflict

Fig. 6- selective harvesting of wood from a shelterbelt

Source: Stack firewood Bavaria Germany (2024)

of whatever magnitude can be resolved as all stakeholders will be involved in the cause of dialoguing. Secondly, most of the conflicts can be avoided so long as all stakeholders will be involved in all process of management or decision making irrespective of their status. Mushove and Vogel (2005) observed that participatory approach allows a method of project design to integrate the interests of disadvantaged and less powerful groups, and also provides a full public participation.

Conclusion

In Yobe State, Nigeria, 98% of the inhabitants depend on fuelwood as a primary source of energy for cooking, and most of it comes from the forest. Many people earn their living by gathering fuelwood. A study was conducted in the Mai Idris Alooma Polytechnic, Geidam, and surrounding communities spanning a distance of about 30km radius. Questionnaire was designed and administered so as to outline a local approach of establishing a sustainable supply of fuelwood to the communities.

Results obtained indicated that the inhabitants have a total population of about 40,000-47,000 while the major stakeholders were found to include: the pastoralists (9%); crop farmers (55%); Mixed Farmers (20%); and others (16%). Average household size is about 10 people per household and the average fuelwood demand per household per week was 4 bundles (24kg).

Total area of woodland was about 19-25km^2, mostly owned by the government, established in its effort to reduce the menace of desertification. Open grazing is the most common method of grazing; with most grazing and forest reserves been converted to farmlands. Fuelwood demands of the area are met when it is imported. Most stakeholders either purchase or gather the product themselves. Conflicts within or between stakeholders do occur. The forest is an important source of food and in some cases, water to the inhabitants.

Yearly fuelwood demand is about 6656-7821tones. Considering a population growth rate of 2%, future fuelwood demand for the next 10years may be about 79870-93850tones. Well planned management strategies have been identified as one way of ensuring sustainable supply. Farm forestry and the adoption of participatory approaches have also been identified as package for

forestry intervention and conflict management respectively.

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